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Water Treatment NOTES

Cornell Cooperative Extension, College of Human Ecology

Lead in Drinking Water

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Introduction

Lead is a soft metal, also known by the chemical symbol Pb. Because of its low melting point and pliability it has been used in numerous products, such as pipes, solder, brass fixtures, crystal, paint, cables, ceramics and batteries.[1] During recent decades considerable research has been conducted on the poisonous effects of this chemical on adults, but more especially on children. Research results have led to several regulation changes, culminating in the Lead and Copper Rule (LCR)[2] of 1991, and to numerous educational programs on how to diminish health risks from lead. This fact sheet addresses the health risks of lead in general, including the several different sources from which it comes. It then focuses on the specific risk from and treatment of lead in drinking water.

Health Risks of Lead[1, 3]

Lead is a poison that affects virtually every system in the body. It may enter the body either through the intestines, the lungs, or the skin. To test if people have been exposed to lead, a blood test is necessary. The level of lead in blood is expressed in micrograms per deciliter (µg/dl).

Lead exposure can have the following health effects:

- it inhibits certain steps in the process of making blood
- it affects the central nervous system and causes: headaches, poor attention span, loss of memory, impulsiveness, and, in very severe poisoning cases (>100 µg/dl), seizures.
- kidney dysfunction
- abdominal pain
- high blood pressure and strokes
- miscarriages, stillbirths and impotence

Used units for drinking water and blood standards
µg = microgram = one-millionth of a gram
µg/L= microgram per liter = part per billion (ppb)
dl = deciliter = one tenth of a liter
µg/d l= microgram per deciliter

Most of these effects are only seen with acute lead poisoning at adult blood lead levels higher than 120 µg/dl. It should be noted that the levels of lead in the blood that cause these health effects are in general only found in people who work with lead (welders, hunters), or in developing countries where the laws are not yet strict enough. In adults, 25 µg/dl is the blood lead level for concern. Adults are in general not at a great risk from lead unless they work with it on a regular basis.

Health effects of lead for Children[1, 3, 4]

Children are the most vulnerable group when it comes to health effects from lead. Most of the time it is impossible to tell if a child has lead poisoning without a blood test. Blood lead levels as low as 6 µg/dl can have adverse effects on the IQ of children, and a safe threshold for blood lead has not yet been determined for children. It has also been shown that with chronic lead exposure children have greater risks later in life of poor examination scores and failure to graduate from high school. Lead affects children much more than adults because their intestines absorb more lead and their developing CNS (central nervous system) is in a far more vulnerable state. Because of the significant effect of lead on the developing brain it is of the highest importance that pregnant and nursing mothers and young children are protected by good prevention plans.

The peak of blood lead values is around 2 years of age and then it decreases, mostly without intervention. When children are screened, all blood levels above 10 µg/dl have action recommendations from the Centers for Disease Control and Prevention (CDC).[5] When children eat lead paint chips (pica) or otherwise ingest lead from dust or soil their blood lead levels can range from 20 µg/dl (dust and soil) to 100 µg/dl (pica). At high doses clinical symptoms become visible: headaches, abdominal pain, clumsiness, behavioral changes, and other ailments that are similar to what is seen in adults.

Sources of Lead

The main sources for lead exposure are paints, drinking water, food, soil dust, kitchen utensils and leaded gasoline. Most adults with lead poisoning work in some way with lead in their workplace. They inhale or ingest the lead dust particles while involved in the production, reclamation or extraction of lead. Over 320,000 workers in the US were exposed occupationally to lead in 1998.[3]

Children, the group most at risk, can be exposed to several different sources of lead, but mainly they ingest the chips or dust from deteriorated lead-based paints. Also soil contaminated with airborne lead from gasoline can be a source, particularly as it gets tracked into the house or if children play outside.[4] Although lead has been banned from gasoline since the late seventies, soils can be still contaminated by it from before the ban. Because children have an active hand-to-mouth-activity, lead-based paints, lead-dust, and lead-soil are the prevalent sources of exposure for them. In 1998, 25 % of the nation's housing still had significant lead-based paint hazards, notwithstanding all the prevention measures that had been taken before then.[6] Other important exposure sources for children are drinking water containing lead and lead in mother's milk.[3, 4] More information about lead in drinking water will be presented later in this fact sheet.

Prevention

In the past three decades the number of children with blood lead levels above 10 µg/dl has been reduced by 80% due to several prevention measures.[7] The first major prevention measure was the removal of lead from gasoline, which resulted in a steep decline of blood lead levels between 1978 and 1980.[3] Other measures were the banning of lead-based paints used in housing and consumer products, the removal of lead solder from canned foods and stricter rules for contamination of water by lead (plumbing).

Although lead-based paints have been banned since 1978, 80% of the houses built before 1950 (23,000,000 units) still contain lead-based paint. The CDC, Environmental Protection Agency (EPA), and the Department of Housing and Urban Development (HUD) are the three key federal agencies that actively work on prevention strategies.[8-10] These strategies revolve around education, abatement, and stronger policies. Although abatement is the best way to remove lead-based paints, it can also aggravate the situation when the abatement is not executed correctly. Numerous lead particles in the house can be inhaled by the children, which in turn can spike the blood-levels.[11] Contact your local department of health or extension office for information about your region's prevention actions.

Drinking water[12]

Drinking water is one of the contributors to high lead levels in children. An estimated 14% to 20% of total lead consumption in children and adults originates from the tap.[2] Surface water and groundwater sources are very low in natural lead; therefore almost all lead in drinking water comes from contact with building plumbing systems, after it has left the water treatment plant or well. The water can come into contact with pipes, solder, fixtures, faucets, water meters, and fittings that might contain lead. Lead plumbing is found primarily in older houses. When water has an acidic pH (also called corrosivity) lead may leach from the plumbing into the water supply. The solubility of lead is 10,000,000 µg/L at low (acidic) pH (5.5) and 1 µg/L at high pH (9.0). All the very large water suppliers have to reduce the corrosivity of their finished water even if it does not exceed the national action level for lead. Other lead exposure to drinking water comes from lead solder (to join copper joints), brass fixtures and water meters. Therefore, make sure that all plumbing parts in your home are ANSI/NSF 61 certified. The ANSI/NSF standard meets requirements for health effects due to drinking water system components.[13] Devices that meet ANSI/NSF standards are either lead-free or have reduced amounts of lead that pass the test.

Prevention and Water Treatment

If you have lead in your plumbing system there are some simple steps that you can take to try to minimize the lead in the water that you use for drinking and cooking. Water that has been in the plumbing for several hours has a higher concentration of lead, so running the tap for 1 to 5 minutes or until the water feels

cool to the touch greatly reduces the lead content in most cases. Never use warm tap water for cooking purposes or for rinsing, because lead dissolves much more easily in warm water. Sometimes running the tap will not help bring down the lead levels. This can be established by doing water tests with tap water at several intervals. Ask your local water laboratory for testing possibilities. Most test prices range between $15-$50 per sample. Always be sure that your laboratory is certified by your state. Go to http://www.epa.gov/safewater/labs/index.html to check the certification online for several states; while other states list their phone numbers on this web site.

If water treatment is necessary there are several options: activated carbon (See fact sheet 3: *Activated carbon treatment of Drinking Water*), reverse osmosis (RO) (See fact sheet 4: *Reverse Osmosis Treatment of Drinking Water*), and distillation.

- The RO method forces water under pressure through a membrane formulated to reject certain substances. In essence, the water is removed from the contaminant. The simplest RO systems consist of a pump, the membrane, and a flow regulator on the waste water. Additionally, there might be a sediment pre-filter to reduce fouling of the RO membrane. A water softener can be used before an RO system when the water is excessively hard. Most of the water entering an RO system is carried off as waste, in some devices as much as 90 percent.
- Activated carbon is a charcoal based porous material that can adsorb dissolved impurities from water. Because at a certain time the adsorption capacity is reached, it has to be replaced regularly. Only activated carbon units that are certified for lead removal should be used.
- Distillation units remove lead by boiling the water, then collecting and condensing the steam. Many impurities are left behind, and nearly contaminant-free water is produced. Most home distillation units have small capacities, from one quart to one-half gallon of water per hour. Water with a high mineral content or suspended solids will rapidly foul the system, and the drinking water produced tastes rather bland. Distillation removes approximately 99 percent of the lead from water.

All these devices have to be certified for lead removal, so always check the certification of the device at http://www.nsf.org. Often they are only installed at one tap that is used for drawing drinking water or water for cooking.

Quick Facts on Lead in Drinking Water

- Municipal supplies of soft, acidic water can dissolve the lead in pipes or solder of residential water systems.
- The highest concentrations of lead occur in new plumbing installations; levels are minimal after five years.
- Drinking water suppliers must monitor drinking water at the tap in homes at risk. If 10 percent of the homes have lead levels above the action level of 15 µg/L, the water supplier must institute corrosion protection, source monitoring, and public education.
- To measure the highest level of lead in drinking water, samples should be taken from the tap after water has been held in the pipes for several hours or overnight.
- Consumption should not be the first daily use of water. Shower or run the tap for three to five minutes before drinking or cooking with water.
- Hot tap water dissolves lead more easily than does cold water.
- High or persistent levels of lead may be removed from water by reverse osmosis, some activated carbon filters, or distillation.
- Boiling drinking water will not remove lead.

Regulations

Currently the lead standard for drinking water is an action level of 15 µg/L (ppb).[2] Public water suppliers have to monitor high-risk residences. If more that 10% of the monitored residences have a first draw lead level higher than the action level, the water supplier is required to (1) provide warning notices and recommend testing for lead, (2) determine what treatment modifications can be implemented, and (3) implement these methods and monitor their effectiveness.[12]

If you are connected to a private water source, and you know you have lead or lead-containing plumbing materials, be sure to test the lead levels periodically. If infants or pregnant women are drinking the water this is especially important.

Economic benefits[3, 4, 11]

The removal of lead exposure for children also provides a national economic benefit related to fewer health problems. Depending on the calculation made, the benefits would range from several billions to hundreds of billions of dollars when all residential lead hazards are removed. Reduced costs of medical treatment for children poisoned by lead, lowered incidence of high blood pressure, heart disease, and strokes in adults, as well as a savings in compensatory education for those suffering from lead-induced retardation would contribute to this benefit.

Summary

Ingesting or inhaling lead in any way is bad for your health and especially bad for children. Their development can be severely impaired by chronic exposure to lead. Fortunately a lot of prevention progress has been made by removing lead from gasoline and banning lead-based paints. Nonetheless, a lot of children are still exposed every day to lead by paint in old houses, lead in drinking water and other sources. Taking steps to limit your own and their exposure has only benefits.

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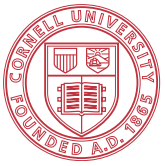

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